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CORALLINE ALGAL AND LARGER FORAMINIFERAL FACIES IN THE PRANG FORMATION (MIDDLE-UPPER EOCENE), JAINTIA HILLS, MEGHALAYA, NE INDIA

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ABSTRACT

The present paper examines coralline algae and larger foraminifera from the Middle-Upper Eocene Prang Formation which crops out in the Jaintia Hills, Meghalaya. Though not uniformly present in the succession, they occur in good number in the interval near the top before finally disappearing at the contact with the overlying Kopili Formation.

The distribution of foraminiferal-algal facies is briefly discussed in respect of the palaeoenvironment which controlled the distribution of the benthic communities (larger foraminifera and coralline algae) in these carbonate deposits. The Prang Limestone was deposited on a transgressive carbonate ramp representing a series of environments in the photic zone ranging from shallow, high-energy shoals to a moderate energy inner-ramp environment forming patch reef-buildups (in the lower part of the succession) to a relatively deeper mid-ramp environment with organogenous mounds below the fair-weather wave base (in the upper part).

Keywords: Coralline algae, larger foraminifera, Prang Formation (Middle-Upper Eocene), Jaintia Hills, Meghalaya, India

INTRODUCTION

During the Palaeogene, extensive marine carbonate platforms developed in the Tethyan-Indo-Pacific region. These Middle-Upper Eocene carbonates with benthic communities were dominated by larger foraminifera and coralline algae which were deposited in a variety of environments in the shallow-water neritic domain (Hottinger, 1997; Aguirre *et al*., 2000; Nebelsick *et al*., 2005). Larger foraminifera comprising nummulitids, alveolinids and discocyclinids have been used as tracers for paleoenvironments (Arni, 1965; Luterbacher, 1984; Cosovic *et al*., 2004; Bassi, 2005). Coralline algal assemblages and their growth-forms, constitute a useful additional palaeoecological tool (Aguirre, 1992; Aguirre *et al*., 1993; Bassi, 1995, 2005; Rasser, 2000; Nebelsick and Bassi, 2000; Rasser and Nebelsick, 2003 and Rasser and Piller, 2004). In the Indian carbonate deposits of this time, these biogenic components have not been given due attention for investigating facies development and palaeoecological interpretation. In the present work, we present results of a study of a succession of coralline algal-foraminiferal facies of late Middle Eocene-Upper Eocene shallow, neritic carbonates of the Jaintia Hills, Meghalaya, NE India. The present study is also of interest in view of the palaeogeographic position of the study area in the Tethys. The purpose of the present paper is to examine possibility of interpreting the basic data on coralline algae and larger foraminifera from the Prang Formation (Middle Eocene-Upper Eocene) in the context of environmental reconstruction in the Jaintia Hills.

The Palaeogene succession of the Jaintia Hills (Meghalaya, India) is characterised by carbonate deposits representing the Sylhet Limestone Group (Wilson and Metre, 1953; Dasgupta, 1977). Though the successions of the Sylhet Limestone units in the East Khasi Hills and the Garo Hills have been studied for foraminifera and calcareous algae (Nagappa, 1959; Pandey, 1972; Mehrotra and Banerji, 1973; Jauhri, 1988, 1994, 1998; Jauhri and Agarwal, 2001; Misra *et al.,* 2002; Jauhri *et al.,* 2006; Kishore *et al.,* 2011), they have received some attention in the Jaintia Hills area with respect to these microfossil groups (Misra *et al.,* 2011; Kishore *et al.,* 2007, 2009; Sarma and Ghosh, 2006; Matsumaru and Sarma, 2010). However, information about facies succession in these carbonates based on biogenic components such as coralline algae and larger foraminifera is not adequate because of poorly documented data on foraminifera and coralline algae and lack of knowledge about their distribution and depositional environment through the succession.

GEOLOGICAL AND STRATIGRAPHICAL SETTING

The study area is a part of the South Shillong Platform, which consists of a thick succession of Cretaceous and Cenozoic shelf sediments. These deposits crop out extensively along the foot-hill region of the southern part of the Shillong Plateau bordering the plains of Assam and Bangladesh (Fig. 1). The Shillong Plateau is one of the geotectonic provinces of the northeastern Indian region which has evolved along with other east-coast basins of India after rifting and subsequent drifting of the Indian plate from eastern Gondwanaland during the Early Cretaceous. Thereafter, the evolution of this region is linked with the tectonics of the Himalayan and Arakan-Yoma regions (Murty, 1983; Acharya, 1986; Naik, 1998; Nandy, 2001; Jauhri and Agarwal, 2001). Palaeogeographically, the study area was at the southern end of the northern Tethys close to the equator (Vandenberghe *et al.,* 2008).

Platform conditions in the Shillong Plateau began with deposition of the Basal Sandstone (Upper Cretaceous) and continued during accumulation of the Langpar shales and

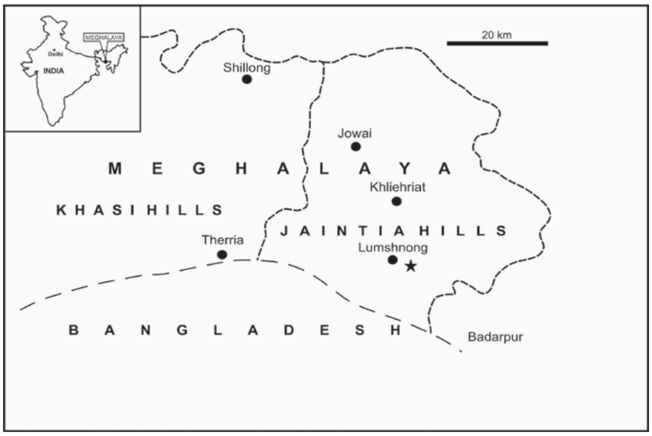


Fig. 1. Location of the study area indicated by (★).

calcareous clays and the Sylhet Limestone (Paleocene to Middle-Upper Eocene). The depositional environment of the platform was controlled by block movements along the basement faults and was marked by lower rates of subsidence and deposition of carbonates from the Upper Palaeocene to the Middle-Upper Eocene. Subsequently, rates of subsidence increased, with the deposition of thicker siliciclastic successions of the Kopili and the Barail formations in the late Eocene and Oligocene respectively, extending well into the Neogene (Murty, 1983; Jauhri and Agarwal, 2001).

Detailed stratigraphical accounts have been given by Wilson and Metre (1953), Nagappa (1959), Chakraborty and Baksi (1972), Dasgupta *et al*. (1964), Dasgupta (1977) and Samanta and Raychoudhury (1983). Following the effusion of the Sylhet Trap, the Shillong Plateau witnessed nearly continuous sedimentation under stable neritic environment from the Cretaceous, depositing the sediments representing the Khasi Group (Cretaceous), the Sylhet Limestone Group (also designated as the Jaintia Group, Upper Palaeocene to Middle-Upper Eocene), the Kopili Formation (Upper Eocene) and the Garo Group (Oligocene-Miocene) (see Nandy, 2001).

Dasgupta *et al.* (1964), Dutta and Jain (1980) and Saxena and Tripathi (1982) presented the account of stratigraphy of the Jaintia Hills area along the Jowai-Badarpur Road. The Sylhet Limestone Group is represented by three mappable lithostratigraphical units: the Lakadong Formation (lower), the Umlatdoh Formation (middle) and the Prang Formation (upper), and includes two sandstone interbeds, one (the Lakadong Sandstone) separating the carbonate member of the lower unit from the middle one, and other (the Nurpuh Sandstone) falling between the carbonates of the middle and the upper units (Figs. 2 and Table 1). The lower unit (Lakadong Formation) is of late Palaeocene-earliest part of Early Eocene age; the middle unit (Umlatdoh Formation) has been dated as Early Eocene in age

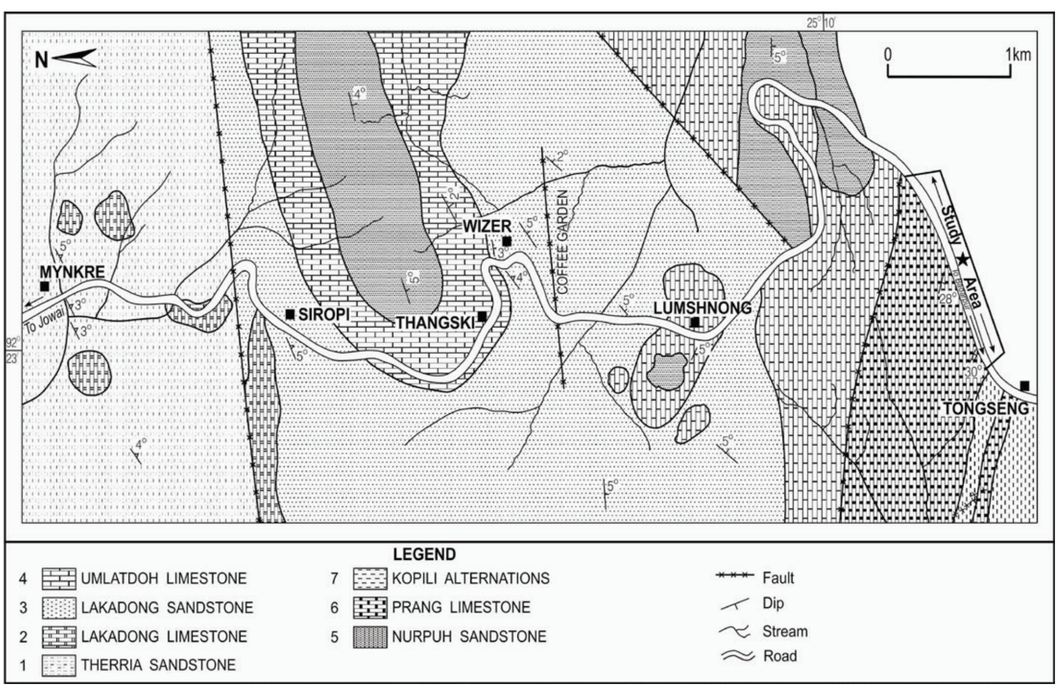


Fig. 2. Geological map of the area between Mynkre and Tongseng, in the Jaintia Hills (based on Datta and Jain, 1980). Samples were collected from the studied section between milestone 128 km and 132.5 km on Jowai-Badarpur Road.

EXPLANATION OF PLATE I

1. Subaxial section of ***Alveolina*** (a) with porcelanaceous calcareous test surrounded by numerous poorly sorted fragments of **nummulitids** (c) and scattered corallines (b) along with broken bioclasts in a packstone-grainstone texture; sample PL 1/85; 2. Two protuberances of coralline algae representing **Melobesioideae** (a) along with a larger fragment of ***Nummulites*** (b) and fragmented coralline algae and smaller pieces of larger foraminifera in a packstone texture; sample PL 2/87; 3. Poorly sorted ***Nummulites*** (b) coralline algae packstone. The larger coralline bioclast (centre, a) is a **melobesioid**; sample PL 1/85; 4. Fruticose protuberances of **melobesioids** (a) and fragmented biogenic components consisting of coralline algae and nummulitids in a poorly sorted packstone; sample PL 3/85; 5. A large fragment of *Assilina* (lower, b) and ***Sporolithon*** (a) with other fragmented biogenic components comprising nummulitids and coralline algae in a packstone; sample PL 1/85; 6. **Nummulitid** packstone containing fragments of ***Nummulites*** (b) and two axially cut ***Assilina*** (c) along with coralline algae present as fruticose protuberances (a); sample PL 4/85. (All sample numbers are prefixed JB/).

Plate I

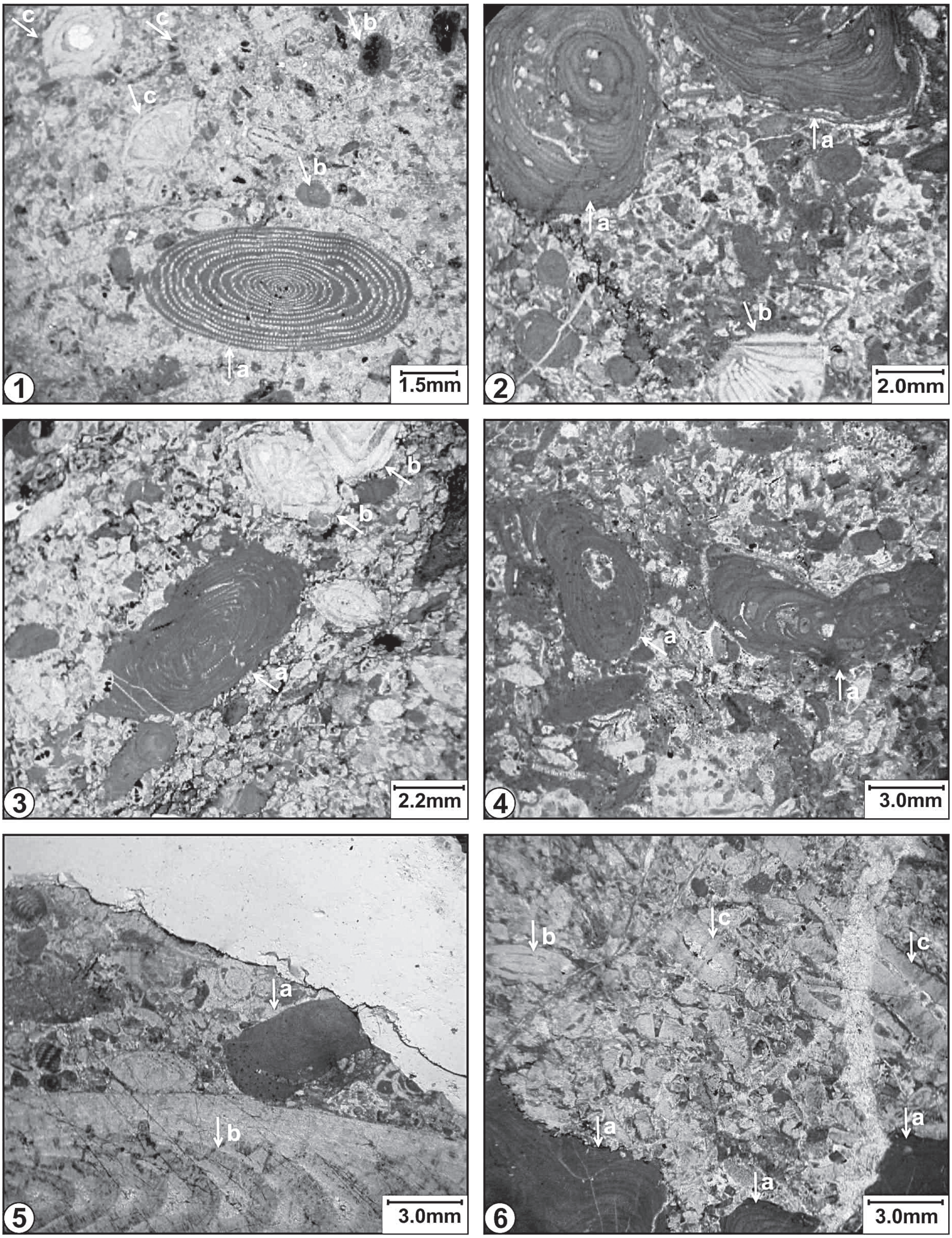


Table. 1. Lithostratigraphic succession in the study area.

KOPILI FORMATION			
SYLHET LIMESTONE GROUP	Prang Formation		Richly fossiliferous, light to dark grey limestone with large nummulitids (50 m)
	Umlatdoh Formation	Nurpuh Sandstone	Arkosic, ferruginous sandstone (20 m)
		Umlatdoh Limestone	Hard, massive foraminiferal limestone (40 m)
	Lakadong Formation	Lakadong Sandstone	Soft, friable, light coloured sandstone with coaly horizons (12 m)
		Lakadong Limestone	Hard, compact, fossiliferous limestone rich in larger foraminifera (100 m)
THERRIA FORMATION		Therria Sandstone	Hard, compact, burrowed, coarse to medium-grained sandstone (30 m)
		Therria Limestone	Hard, compact, unbedded limestone (100 m)
LANGPAR FORMATION			

and the upper unit (Prang Formation), though considered to be late Middle Eocene in age (Nagappa, 1959; Mehrotra and Banerji, 1973; Singh *et al.,* 1986; Jauhri and Agarwal, 2001), overlies the Nurpuh Sandstone of the Umlatdoh Formation and in turn is overlain by the Kopili Formation (Late Eocene). The Prang Formation is dated here as Middle-Late Eocene in age on the basis of presence of *Pellatispira* in the upper part of its succession (Fig. 3).

BIOSTRATIGRAPHIC CORRELATION OF THE PRANG FORMATION

The Prang Formation is the uppermost lithostratigraphic unit of the Sylhet Limestone, is about 16.5 m thick in the study area and is grey to blue limestone becoming ferruginous at the top. Dasgupta (1977) proposed the name "Sylhet Limestone Stage" which corresponds to the "Nummulitic Series" of Medlicott (1871) and to the two main lithounits of Wilson and Metre (1953). The name Jaintia Group (earlier proposed by Evans, 1932) as the Jaintia Series to include these rocks) is also in use (Dutta and Jain, 1980; Saxena and Tripathi, 1982; Murty, 1983, etc.), though Dasgupta's (1977) proposal has proved to be quite practicable in the field and is followed in the present work.

The Prang Formation is a richly fossiliferous unit characterized by bivalves, gastropods and nummulitic fauna useful as biostratigraphical indices. Nagappa (1959) and Mehrotra and Banerji (1973) noted the presence of Kirthar (Kirthar stage of Pakistan, equivalent to middle Eocene) elements in the Prang Formation. Important biostratigraphical markers in the lower 9.78m interval include the larger foraminifera species, e.g. *Nummulites beaumonti* d'Archiac and Haime, *N. perforatus* (de Montfort), *N. acutus* (Sowerby), *N. striatus* (Bruguière), *Discocyclina dispansa* (Sowerby) and *Alveolina elliptica* (Sowerby) whose precise age has been indicated as ranging from SBZ 15 to SBZ 18 in the Shallow Benthic Zonation (Serra-Kiel *et al.,* 1998). In other sections of Meghalaya, their association with planktic foraminifera in the equivalent Siju Limestone of the Garo Hills has been recorded by Samanta (1969), who established their correlation with Zones P13 and P14 of the planktic foraminiferal zonation of Blow (1969, 1979). However, in the upper 7.72 m interval (from sample No. JB/PL7 onwards) *Pellatispira* is observed in association with *Nummulites striatus* and *Discocyclina dispansa*. The presence of *Pellatispira* suggests that the upper part of the Prang Limestone in the study area is Late Eocene in age, corresponding to late SBZ 18-19, i.e. zone late P15. Based on these stratigraphical indices, the Prang Formation in the study area seems to range from the late Lutetian-Bartonian to Priabonian stages, i.e. Middle-Late Eocene (Fig. 3).

MATERIAL AND METHODS

The samples for this study have came from the Prang Formation, a carbonate unit, exposed around the Lumshnong area which is located on the southeastern slope of the Shillong Plateau on the Jowai-Badarpur Road at a distance of 128 km southeast of Shillong (Fig. 2). The samples were collected and stratigraphic sections were measured, with sample position (Fig. 4). The samples were processed for thin-section study of larger foraminifera and coralline algae. The material was studied in random thin sections, and some oriented sections obtained with respect to specimen's architecture. This was followed by taxonomic determination, comparison and photomicrography.

The Palaeogene sequence (Palaeocene-Eocene) of shallow, neritic facies is exposed along the Jowai–Badarpur Road between Jowai (64 km milestone) and Sonapur (140 km milestone). It is represented by the Therria Formation exposed

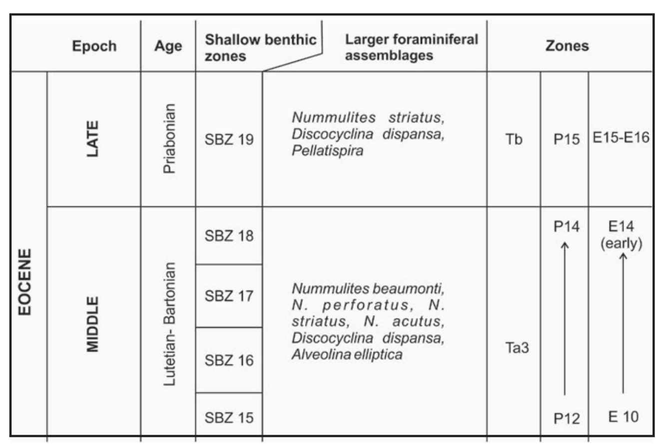
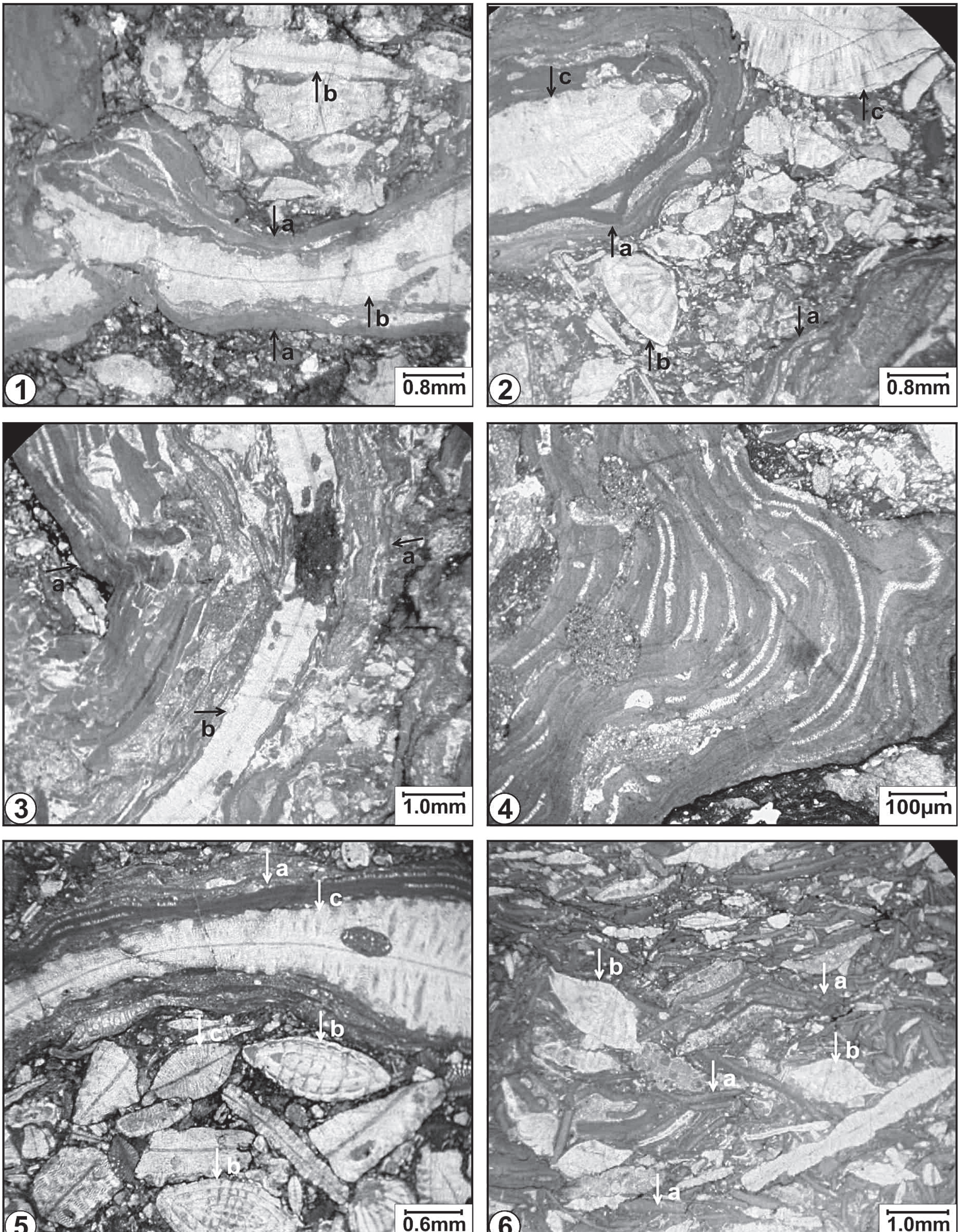


Fig. 3. Correlation of Shallow Benthic Zones (Serra-Kiel *et al*., 1998) recognized in the studied section of the Prang Formation with standard zonations; T zones refer to the Letter classification of the Far East (Adams, 1970; Matsumaru, 1996); P and E zones refer to the planktonic foraminiferal zonation (Berggren and Pearson, 2006).

EXPLANATION OF PLATE II

1. **Discocyclinid** foraminifer (b), encrusted by **Melobesioideae** (a) forming algal boundstone surrounded by larger foraminiferal bioclasts in a packstone; sample PL 5/85; 2. Wackstone-packstone facies with bioclasts of ***Nummulites*** (b) and ***Discocyclina*** (c) which is encrusted by coralline algae – ***Spongites*** (a), binding associated bioclasts; sample PL 6/85. Pl. 9; 3. Algal boundstone consisting of melobesioids (a) encrusting on *Discocyclina* (b); sample PL 9/85; 4. ***Sporolithon*** cf. ***aschersoni*** showing warty growth form and tetra/biosporangial sori arranged in several rows, sample PL 9/85; 5. Poorly sorted packstone of ***Discocyclina*** (c) and ***Nummulites*** (b). ***Discocyclina*** (B-form) is encrusted by melobesioid crusts (a); sample PL 10/85; 6. Lamellate (layered) growth-form (a) and bioeroded with ***Nummulites*** (b) and discocyclinids in a packstone; sample PL 12/85. (All sample numbers are prefixed JB/).

Plate II


1
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a
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5
a
c
c
b
b
0.6mm
6
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a
b
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a
1.0mm

unconformably over the Precambrian Shillong Group in the road section near Jowai up to 110 km milestone, the formations of the Sylhet Limestone (exposed between 110 km milestone and 131.5 km milestone) and the Kopili Formation (cropping at 132.5 km milestone and extending up to 140 km milestone). This succession is summarized in Table 1, Fig. 2, Fig. 4.

RESULTS

Microfossil components

The samples have yielded a rich assemblage of foraminifera and coralline algae. The distribution of both the fossil groups was studied. Fig. 5 shows distribution of foraminiferal-algal components through the succession. Among the foraminifera, the species of *Alveolina, Assilina, Discocyclina, Nummulites* are commonly represented, e.g. *Alveolina elliptica* Sowerby, *Assilina papillata* Nuttall, *Discocyclina dispansa* (Sowerby), *Discocyclina* sp., *Nummulites beaumonti* d'Archiac, *Nummulites striatus* (Bruguière), etc. The foraminiferal assemblage in the lower 6 m of the succession is characterized by *Nummulites* and *Alveolina*, the latter showing up in the lowermost 2 m interval only. The overlying 4m interval of the lower sequence shows predominance of nummulitids. *Discocyclina* and *Nummulites* are the dominant foraminifera in the overlying 10.7m interval and are accompanied by *Pellatispira* at some levels (from samples JB/PL7 onwards).

Coralline algae include species of Melobesioideae, *Sporolithon, Spongites, Lithoporella, Mesophyllum* besides some indeterminate fragments of geniculates. The algal flora of the lower part is poorly represented and mainly include melobesioids with some of the fragments of *Sporolithon* near the base; the overlying 10.7m succession is marked by the varied forms of coralline algae showing presence of Melobesioideae in abundance along with a few mastophoroids and *Sporolithon* in some intervals.

Facies Description

The coralline algae and foraminiferal associations can be broadly grouped into three distinct facies on the basis of algal-foraminiferal composition and growth-forms:

(i) *Nummulites*-*Alveolina*-Melobesioideae (**NAM**) facies (2m): This facies is characterized by grainstones-packstones dominated by tests of *Nummulites*, most of which are small and fragmented. Associated with the nummulitids are *Alveolina*, miliolids and a few rotaliids. The coralline algae are poorly represented and occur as fragments referable to Melobesioideae and *Sporolithon* (Fig. 5; Pl. I, fig. 5).

(ii) *Nummulites*-Melobesioideae (**NM**) facies (4m): This facies, represented by packstones, is characterized by large-sized *Nummulites* in great abundance accompanied by rare fragments of discocyclinids and *Assilina*. Fragmented forms of coralline algae referable to Melobesioideae are common.

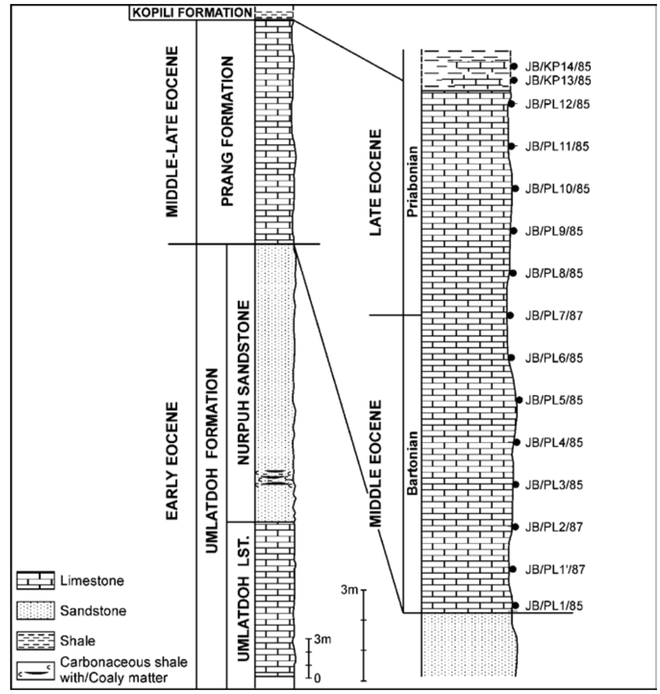


Fig. 4. Lithostratigraphic column showing stratigraphic position of the Prang Formation in the Palaeogene succession of the study area and position of samples of the Prang Formation.

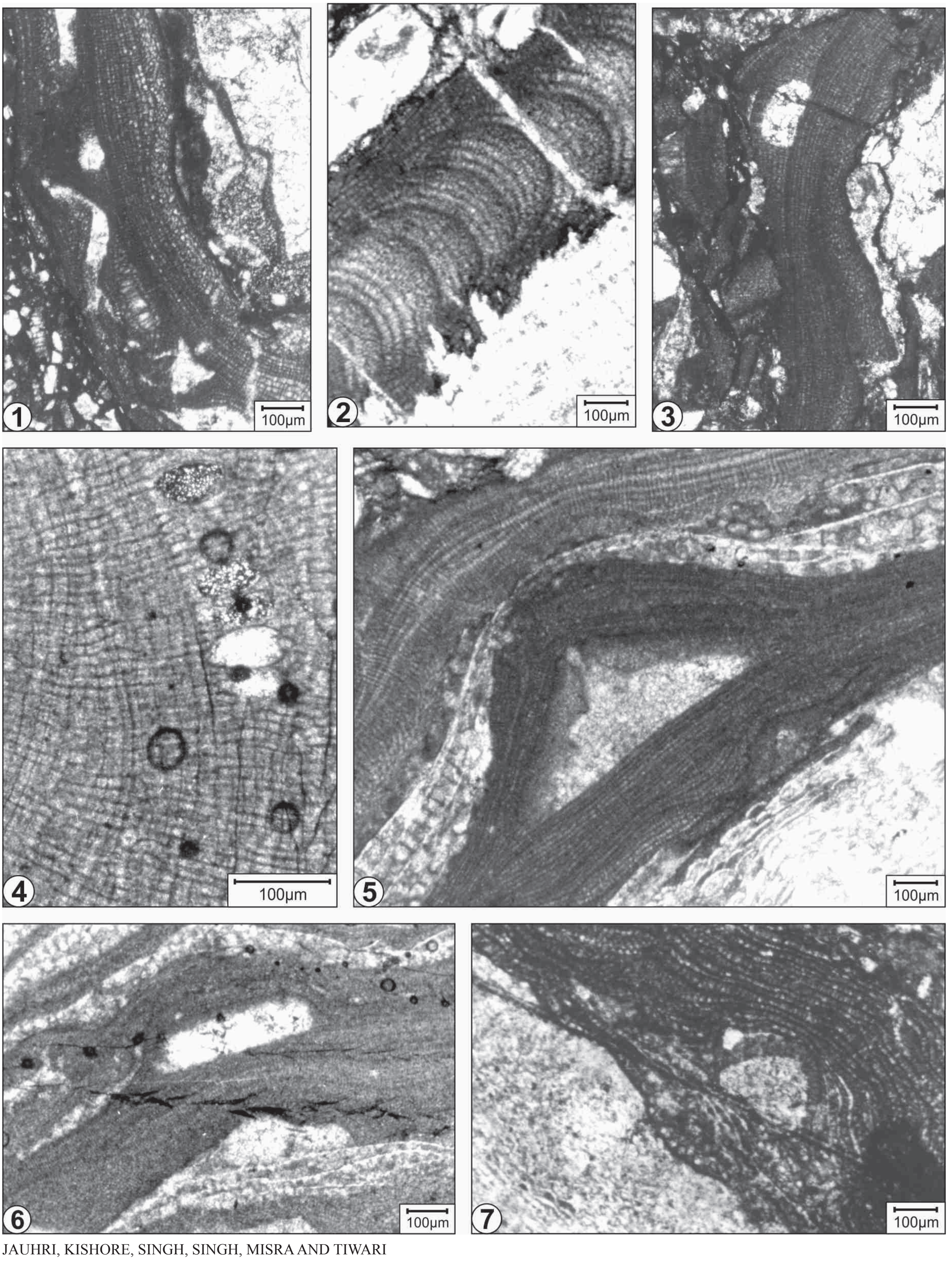
The coralline algal growth forms are characterised by fruticose protuberances (Fig. 5; Pl. I, Fig. 4).

(iii) *Discocyclina*-*Nummulites*-Melobesioideae-*Sporolithon* (**DNMS**) facies (10.7m): This facies consists of coralline crust boundstones with wacke- to packstones and is dominated by discocyclinids, mostly represented by B-form, and *Nummulites*. Other associated foraminifera are *Assilina*, *Operculina* and fragments of few unidentifiable forms. Coralline algae are not as abundant as larger foraminifera, but are more diverse here than in NAM and NM facies. They include Melobesioideae gen et spec. indet 1, Melobesioideae gen et spec. indet 2, *Sporolithon lugeoni*, *S.* cf. *aschersoni*, *Lithoporella melobesioides*, *Spongites* sp. 3 and *Mesophyllum* sp. The dominant growth forms of this facies are encrusting (Pl. II, figs. 1-3), warty (Pl. II, fig. 4) and lamellate (layered) types (Pl. II, fig. 5). The common encrusting growth form in this facies is comparable to the *Type 2* encrusters known to colonize hard biogenic substrates (Nebelsick and Bassi, 2000) which, in the present case, are the tests of *Discocyclina* and *Nummulites*. While warty and encrusting growth forms occur in the intervals of the facies succession represented by samples PL5, PL6, PL9, PL10, lamellate (layered) types are represented in the uppermost part (Fig. 5, Pl. II, figs, 1-6).

EXPLANATION OF PLATE III

1. **Melobesioideae** gen. et spec. indet. 1, encrusting growth form x 70, Sample-JB/PL11/85; JB/PL9/85; Locality-Jaintia Hills; Horizon-Prang Formation. 2. **Melobesioideae** gen. et spec. indet. 3, fruticose growth form of thallus x 70, Sample-JB/PL1/85; JB/PL2/85; Locality-Jaintia Hills; Horizon-Prang Formation; 3. ***Mesophyllum*** sp., encrusting growth form x 70, Sample-JB/PL12/85; Locality-Jaintia Hills; Horizon-Prang Formation; 4. ***Sporolithon lugeoni*** (Pfender) Moussavian and Kuss, 1990, an enlarged view of the thallus showing tetra/bisporangial conceptacles x 200, Sample-JB/PL1/85; Locality-Jaintia Hills; Horizon-Prang Formation; 5. ***Spongites*** sp. 1, *sensu lato* Bassi, 1998, showing encrusting growth-form and uniporate conceptacle x 70, Sample-JB/PL6/85; Locality-Jaintia Hills; Horizon-Prang Formation; 6. **Melobesioideae** gen. et spec. indet. 2 showing encrusting growth form x 70. Sample-JB/PL5/85; Locality-Jaintia Hills; Horizon-Prang Formation; 7. ***Lithoporella melobesioides*** (Foslie) Foslie. Thallus showing uniporate conceptacle and encrusting growth form x 70, Sample-JB/PL6/85; JB/PL9/85; Locality-Jaintia Hills; Horizon-Prang Formation.

Plate III



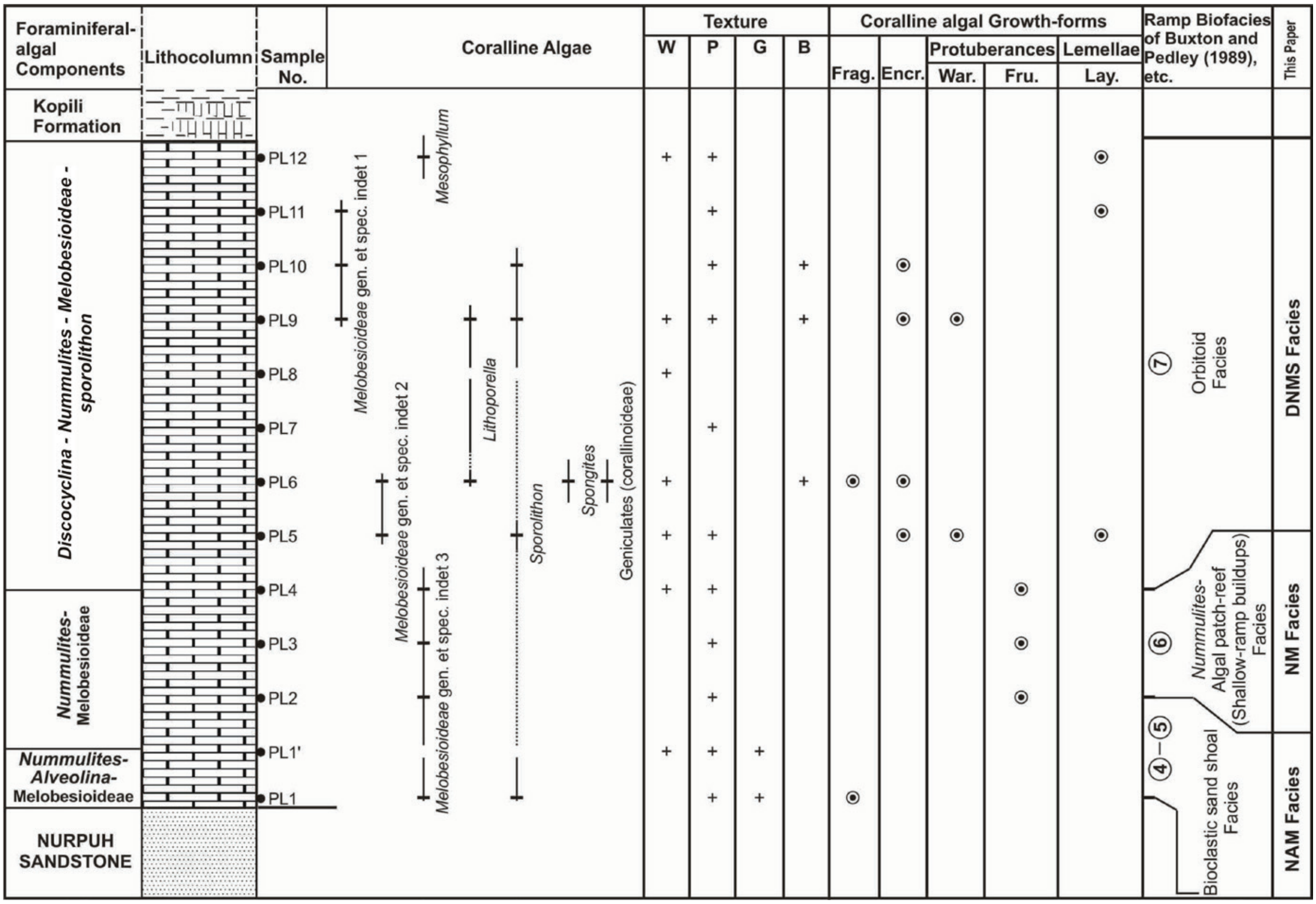


Fig. 5. Distribution of coralline algal taxa, growth-forms and texture in the facies of the Prang Limestone outcrops in the Jaintia Hills (W = wackestone; P = packstone; G = grainstone; B = boundstone; Frag. = fragmented; Encr. = encrusting; War. = wart; Fru. = fruticose; Lay. = Layered; all samples are prefixed JB/ species and growth forms in the Prang Formation.

DISCUSSION

The larger foraminiferal and coralline algal facies can be interpreted in terms of hydrodynamic energy (turbulence) and depth of deposition (bathymetry). The taxonomic composition of foraminifera and calcareous algae and coralline algal growth-form morphologies have been shown to vary with changes in depth and hydrodynamic conditions both in modern and ancient environments (Adey and Adey, 1973; Hottinger, 1983, 1997; Luterbacher, 1984; Hallock and Glenn, 1986; Burchette and Wright, 1992; Gherardi and Bosence, 1999; Hohenegger, 2000; Nebelsick *et al.,* 2000; Nebelsick and Bassi, 2000; Flügel, 2004; Cosovic *et al.,* 2004; Bassi, 2005; Accordi *et al.*, 2014; etc.). These studies provide a sound basis for applying the results of their observations in the interpretation for palaeoenvironment in the present area.

NAM Facies was deposited in an inner-ramp environment of high-energy conditions. This is supported by dominantly grainstone texture and presence of *Nummulites* and *Alveolina* which, together with other organisms such as gastropods, infaunal bivalves, etc., are characteristic of higher-energy conditions such as those that occur during deposition of bioclastic shoals of inner ramps (Fig. 6). This facies is comparable to the nummulitid-alveolinid facies recognized in the lower part of the Eocene foraminiferal limestones of Istrian Peninsula (Cosovic *et al.,* 2004) and the *Alveolina-Nummulites* packstone-grainstne (Z18) facies of Accordi *et al.* (2014). Poorly represented, fragmented crusts of melobesioids and *Sporolithon* (Pl. I, fig. 5) reinforce this interpretation.

NM Facies is characterized by predominant nummulitids, relatively increased numbers of coralline algae (melobesioids) with fruticose growth forms (Pl. I, fig. 4) and high amounts of muddy matrix, all indicating relatively lower water turbulence (moderate energy) and improved habitat conditions during deposition. Less turbulent energy conditions favour colonization of coralline algae and preservation of fruticose growth forms (Nebelsick and Bassi, 2000). Nummulitids are considered to be the chief constituent of shallow ramp buildups (patch-reef belt) in association with coralline and codiacean algae, burrowing and boring bivalves, encrusting foraminifers, etc. (Buxton and Pedley, 1989), and are found in the sediments of bioherm facies with a depth range from 10m to 40m on carbonate shelf environments (Berggren, 1974; Hottinger, 1983). NM Facies corresponds to Buxton and Pedley's (1989) ramp biofacies 6. It is also comparable with the nummulitic patch-reefs of Aigner (1982) and Luterbacher (1984), crustose coralline-foraminiferal packstone facies (L7) of Accordi *et al.* (2014) and the microfacies B of the Dernah Formation, NE Libya (Abdulsamad and Barbieri, 1999) representing nummulite shoals developed below fair-weather wave base, similar to those of the Eocene foraminiferal limestone of the Adriatic peninsula (Cosovic *et al.,* 2004).

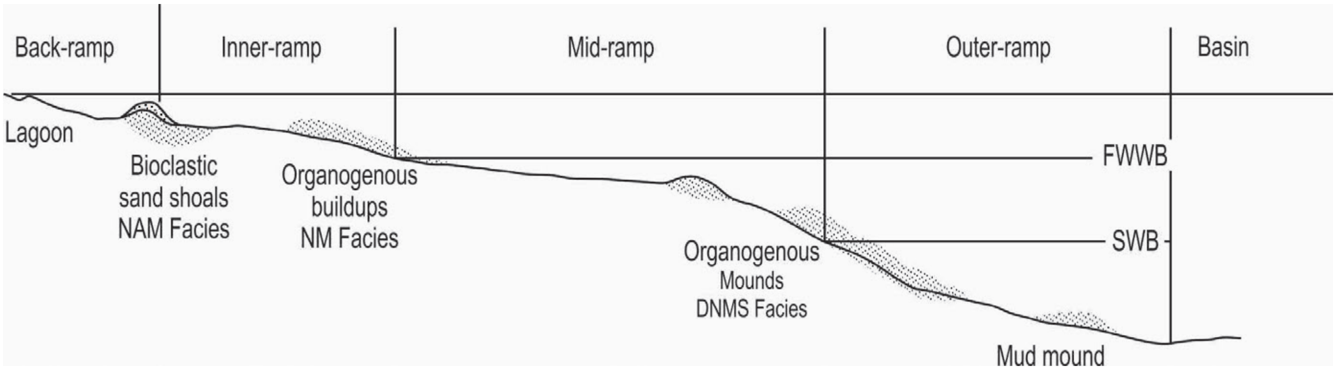


Fig. 6. Idealized ramp profile showing lateral distribution of foraminiferal-calcareous facies in the Prang Limestone in the area (modified from Flügel, 2004 and Burchette and Wright, 1992).

DNMS Facies, with well-preserved coralline algae dominated by Melobesioideae (with subordinate *Sporolithon*, *Lithoporella* and *Spongites* (see Pl. III) at some intervals) and larger foraminifera with dominant discocyclinids, was deposited in a relatively deeper mid-ramp environment characterized by low-energy conditions. Melobesioids are known to colonise relatively calm waters at greater depths in ramp setting (Braga and Aguirre, 2001). The dominance of encrusting (Pl. II, figs. 1,2,3,5), warty (Pl. II, fig. 4) and layered (lamellate) growth forms (Pl. II, Fig. 6) of coralline algae supports this interpretation. Abundance of *Discocyclina* and absence of miliolids and alveolinids are good indicators of deeper ramp conditions. *Discocyclina* is a common constituent of orbitoid facies (Buxton and Pedley, 1989) deposited below fair-weather wave base but above storm wave base in middle ramp setting. Hottinger (1983, 1997) noted that *Nummulites* and *Discocyclina* occupy an environment within upper photic zone, between 40m and 80m depths. DNMS Facies corresponds to Buxton and Pedley's (1989) biofacies 7 (orbitoid facies) (Fig. 6), the microfacies II of Cosovic *et al.* (2004) in the Adriatic carbonate platform and the LZ14 facies (outer ramp sequence) of Accordi *et al.* (2014) in the Ionian islands. Such facies types had widespread distribution in the Tethyan realm during the Eocene and might have been deposited at >80m depths.

CONCLUSIONS

The Prang carbonate deposits have preserved a relatively good sequence of the coralline algal-larger foraminiferal assemblages that colonized the carbonate platform during the Middle-Late Eocene transgression in the study area. The changes noticed in the taxonomic composition and diversity of larger foraminifera and coralline algae, along with the changes in algal growth-form morphology through the succession are linked with changing environmental conditions. Facies development in the studied sequence shows responses to changing bathymetry and hydrodynamic conditions.

The changes from facies at the base to that at the top represent sequential deposition in a relatively deepening transgressive sea on a ramp profile characterized predominantly by larger foraminifera and coralline algae. The major changes constitute (i) low-diversity, fragmented corallines (melobesioids), nummulitids and alveolinids at the base comprising NAM facies as deposited in a high-energy area as bioclastic sand shoals of inner ramps, (ii) the melobesioids and nummulitids of the succeeding unit representing NM facies reflecting features associated with shallow ramp build-ups formed under relatively reduced (moderate) energy conditions, and (iii) the unit representing DNMS facies characterized by diversified coralline algal assemblage (dominated by melobesioids in general and marked by mastophoroids and sporolithaceans in some horizons) with encrusting, warty and layered growth forms and abundant larger foraminifera including *Discocyclina* and nummulitids. The latter forms have developed in response to the relatively quiet-water, mid-ramp environment by forming organogenous mounds below the fair-weather wave base.

In the context of the interpreted carbonate ramp, it is suggested that the depositional environment of the Prang Formation appears to have shifted from the shallow subtidal inner-ramp to deeper mid-ramp setting which resulted in decreasing hydrodynamic energy and a progressive increase in depth of deposition. Additionally, increasing water depths and decreasing hydrodynamic energy may have also caused changes in habitat conditions resulting in the development of depth-controlled benthic communities of larger foraminifera and coralline algae.

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